



Association between Dietary Nutrient Intake and Depressive Symptoms among Japanese Postpartum Women: An Observational Cross-sectional Study

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ABSTRACT

Background: Low dietary nutrient intake may be associated with depressive symptoms. However, few such studies have been conducted among postpartum women and results have been controversial.

Purpose: To investigate the association between dietary nutrient intake and depressive symptoms among Japanese one-month postpartum women.

Methods: This cross-sectional study was conducted at a university hospital in Tokyo from June 2015 to September 2016. We recruited healthy women with healthy babies at their postpartum check-up. Dietary nutrient intake was assessed using a validated, brief-type, self-administered diet history questionnaire. Depressive symptoms were defined as a score of ≥ 9 on the Edinburgh Postnatal Depression Scale. Multiple logistic regression analysis was performed to identify if dietary nutrient intake was associated with depressive symptoms. Variables with P-values < 0.10 in the bivariate analysis and factors identified as important, based on the literature review, were included. $P < 0.05$ was considered significant.

Results: Data from 246 participants were analyzed. Depressive symptom prevalence was 19.5%. Participants with an educational level above university level comprised 69.1%, and 68.3% of participants had a household income of ≥ 7 million Japanese yen. In the multivariate analysis, dietary nutrient intake was not significantly associated with depressive symptoms. However, higher educational level and need for emotional support as assessed by midwives or nurses were significantly associated with an increased risk of depressive symptoms.

Conclusion: Dietary nutrient intake was not significantly associated with depressive symptoms in this high socioeconomic status population. Further research is needed to identify the relationship between dietary intake and depressive symptoms among more socioeconomically diverse postpartum women. Additionally, it may be important for postpartum depression support systems to pay attention to highly-educated women and to undertake continued follow-up for women who are assessed by midwives or nurses as needing emotional support either during pregnancy or while in the hospital.

Keywords: Diet; Edinburgh Postpartum Depression Scale; nutrient; postpartum depression; socioeconomic status

BACKGROUND

Postpartum depression (PPD) occurs after childbirth and is characterized by typical symptoms of major depression such as depressed mood, lack of pleasure, feelings of guilt, loss of energy, concentration difficulties, and recurrent thoughts of death (Yonkers et al., 2011). In the first month following childbirth, particularly, child-rearing anxiety and the burden of responsibility, compounded with the lack of sleep resulting from breastfeeding and cradling the baby, can easily lead to psychological instability (Sakanashi et al., 2015). Therefore, this first month after childbirth is regarded as a period with an increased risk of PPD (Mori et al., 2011). PPD negatively affects not only the mother herself, but also the cognitive, social, and emotional development of her children (Letourneau et al., 2012). Additionally, it affects the marital relationship and family functionality (Letourneau et al., 2012). Therefore, prevention and early detection of PPD are recognized as important issues of perinatal care.

Presently in Japan, the need for PPD screening in the early postpartum period (at 2 and 4 weeks postpartum) using the Edinburgh Postnatal Depression Scale (EPDS) that evaluates depressive symptoms, has been emphasized (The Japan Society of Obstetrics and Gynecology, 2016). The prevalence of depressive symptoms as assessed by the EPDS in Japan was reported to be approximately 11% within one month after childbirth at a cut-off point of 8/9 (Mori et al., 2011).

Although the mechanism of development of PPD is unclear, factors associated with its development have been examined. These relevant factors include demographic and socioeconomic attributes (e.g., age, low household income, low educational level, unemployment, and unmarried status) (Liu et al., 2022; Matsumura et al., 2019; Miyake et al., 2011; Mori et al., 2011; Zhao & Zhang, 2020), obstetric factors (e.g., primiparous, premature birth, cesarean section, instrumental delivery, obstetric complications, multiple birth, infertility treatment, and excessive bleeding) (Liu et al., 2022; Mori et al., 2011; Zhao & Zhang, 2020), and psychosocial factors (e.g., history of mental illness, prenatal anxiety, prenatal depression, maternity blues, neuroticism, low self-esteem, unplanned/unwanted pregnancy, lack of social support, childcare stress, life stress, and low marital satisfaction) (Liu et al., 2022; Mori et al., 2011; Zhao & Zhang, 2020).

Moreover, lower dietary intake of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) as n-3 polyunsaturated fatty acids, vitamin D, B vitamins (vitamin B2, B6, B12, and folate), and minerals (iron and zinc) have been suggested as factors associated with PPD (Ellsworth-Bowers & Corwin, 2012; Rechenberg & Humphries, 2013). These nutrients are profoundly related to brain function and play an important role in the synthesis and absorption of neurotransmitters. Additionally, these nutrients are associated with neuroendocrine and/or immune functions that trigger PPD. Therefore, it has been suggested that the risk of developing PPD could be increased by inadequate consumption of these nutrients.

Previous studies have investigated the association between dietary intake of n-3 polyunsaturated fatty acids, vitamin D, B vitamins, glycemic index diet, and dietary patterns in pregnancy and depressive symptoms in the postpartum period among Japanese women (Hamazaki et al., 2018; Hamazaki et al., 2020; Miyake et al., 2006; Miyake et al., 2006; Murakami et al., 2008; Okubo et al., 2011; Tsunoda et al., 2023). However, associations were not consistent. In these previous studies, the obstetric factors associated with the development of PPD were inadequately assessed. Additionally, lifestyle and dietary habits of women change considerably before and after childbirth (Nishimura et al., 2008). Therefore, it is necessary to assess dietary nutrient intake during the postpartum period, and to investigate the association between the intake of nutrients that are thought

to be associated with PPD and depressive symptoms, focusing on one month after childbirth.

OBJECTIVE

This study aimed to investigate the association between dietary nutrient intake and depressive symptoms among Japanese women at one month postpartum.

METHODS

Study design and participants

A cross-sectional study was conducted at a university hospital in Tokyo, Japan, from June 2015 to September 2016. We enrolled healthy women with healthy babies at their one month postpartum check-up. The exclusion criteria were age < 20 years; inadequate Japanese literacy; being hospitalized; receiving nutritional guidance for hypertension, diabetes, or other illnesses; participation in another study with individualized nutritional guidance during pregnancy; mental illness under treatment; and serious disease, death, or hospitalization of the infant.

Procedures

Eligibility was checked using the list of patients who were scheduled for a postpartum check-up. Eligible women were provided with a description of the research in an outpatient waiting room. Upon signing the informed consent form, participants were given the questionnaires which they were asked to complete either immediately or at home. If the questionnaires were completed at home, participants were asked to return the completed questionnaires within a week by postal mail. If the questionnaires were not returned after two weeks, the researchers contacted the participants via phone or sent an e-mail reminder. Furthermore, if the questionnaire was only partially completed, clarification was obtained by contacting the participants directly, by phone, e-mail or postal mail.

Variables

Dietary nutrient intake

Dietary nutrient intake was assessed using a validated, brief-type, self-administered diet history questionnaire (BDHQ) (Kobayashi et al., 2011; Kobayashi et al., 2012). The BDHQ has been validated by the 16-day weighing diet recording method, considered the gold standard method, and is easily answered by respondents without a specialist's help, making it useful for epidemiological research. The BDHQ is a 4-page questionnaire on dietary habits recalled the previous month, and collects the intake frequency of 58 foods and beverages such as fixed-portion size. Self-administration of the BDHQ takes approximately 15 min. Therefore, we considered this to be a minimal burden of research for postpartum women engaged in child-rearing.

An analysis software specialized for use with the BDHQ was utilized to determine the amounts of nutrients consumed, including n-3 polyunsaturated fatty acids (such as EPA, DHA, and alpha-linolenic acid), EPA, DHA, vitamin D, B vitamins (vitamin B2, B6, B12, and folate), and minerals (iron and zinc). For the dietary intake of EPA and DHA, we used the sum of the dietary intake of EPA and DHA, as suggested in a previous study (Murakami et al., 2010). In the analysis, the intakes were energy-adjusted using the density method to reduce intra-individual measurement errors (Willett et al., 1997). Women who reported an extremely unrealistic energy intake were excluded from all analyses. We considered a reported energy intake < 0.5 times the energy requirement for

postpartum women in the lowest physical activity category or ≥ 1.5 times the energy requirement for postpartum women in the moderate physical activity category as being extremely unrealistic (Ministry of Health, Labor and Welfare, 2020).

Depressive symptoms

Depressive symptoms were evaluated using the Japanese version of the EPDS (Okano et al., 1996), which was originally developed by Cox (Cox et al., 1987). The EPDS is a self-reported scale designed to screen for PPD. It consists of 10 items asking women how they felt in the last 7 days. Each item is scored on a 4-point Likert scale (from 0 to 3), and the total score ranges from a minimum of 0 to a maximum of 30. In the Japanese version, the cut-off point is set at 8/9 points, which gives a reported specificity of 93% and sensitivity of 75% (Okano et al., 1996). In this study, we defined the participants with an EPDS score of ≥ 9 as having depressive symptoms. The Cronbach's alpha coefficient of the EPDS was 0.83 in the present study.

Participants' characteristics

The participants' characteristics were collected from the self-administered questionnaire and medical charts.

Demographic and socioeconomic characteristics, including age, pre-pregnancy body mass index (kg/m²), body weight at final prenatal check-up (kg) and at one month postpartum (kg), educational level, annual household income, employment status, and marital status were collected. Weight change during the first month postpartum was determined by subtracting the weight (kg) at the final prenatal check-up from the weight (kg) at one month postpartum.

Data on obstetric factors, including parity, delivery mode, infertility treatment, amount of bleeding at delivery, hemoglobin level (g/dL) in the last trimester (35–36 weeks) and during postpartum hospitalization, gestational weeks at delivery, infant's birth weight (g), and infant's sex, and breastfeeding status were collected.

Psychosocial factors, including a history of mental illness and family support status during the first month postpartum were collected. Additionally, information on special needs for emotional support for either anxiety during pregnancy or maternity blues after childbirth identified by health professionals was also abstracted from nursing records. Information during pregnancy was obtained from medical charts reporting prenatal check-ups as written by midwives or nurses after individual health guidance was given. Information after childbirth was taken from medical charts whose nursing care plans state that they required emotional support.

Dietary characteristics, including giving attention to dietary intake and use of supplements (e.g., with or without using supplements and freely describing the type of supplements), were collected.

Statistical Analysis

First, as we wanted to only analyze healthy postpartum women, those who were on treatment for any disease (such as hypothyroidism) were excluded from the analysis. Additionally, women who have had multiple births, and those not breastfeeding were also excluded from the analysis because these factors were reportedly associated with PPD (Liu et al., 2022; Zhao & Zhang, 2020) and may influence eating behavior.

Second, demographic variables were compared between both groups (EPDS score ≥ 9 and EPDS score < 9) using the Student's t-test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables. To compare the dietary intake between both groups, the Mann-Whitney U test was performed. A multiple logistic regression analysis was performed to examine associations between dietary nutrient

intake and depressive symptoms, with depressive symptoms being the dependent variable. Variables with $P < 0.10$ in the bivariate analysis and factors identified as important based on a review of the literature were included in a multivariable model via a forced entry procedure. Multicollinearity was evaluated using the Spearman's rank correlation coefficient (ρ) before conducting the multivariate analysis. Because strong correlations ($\rho = 0.86\text{--}0.90$) were observed between nutrients of interest in this study, models were constructed for each nutrient. In all analyses, $P < 0.05$ was considered significant.

All statistical analyses were performed using the SPSS software version 24.0 for Windows (IBM Corp., Armonk, NY, USA).

Ethical considerations

All participants received information regarding the study, and provided written informed consent. This study was approved by the Research Ethics Committee of the Graduate School of Medicine, the University of Tokyo (No. 10536-(3)).

RESULTS

Participant selection

Of the 469 women who met the study eligibility criteria, 317 agreed to participate (participation rate: 67.6%), and 285 responded to the questionnaire (response rate: 89.9%). Before conducting the analysis, 39 women were excluded for the following reasons: missing data related to important variables ($n = 7$), multiple births ($n = 6$), treatment for thyroid disease ($n = 10$), not breastfeeding ($n = 9$), and unrealistically low energy intake ($n = 7$). Therefore, the data from 246 women (valid response rate: 77.6%) were included in the final analysis.

Participants' characteristics and dietary nutrient intake

As shown in Table 1, the mean (standard deviation, SD) maternal age was 35.2 (4.5) years; 138 (56.1%) participants were > 35 years, and 145 (58.9%) were primiparous. Most participants had an education above university or postgraduate level ($n = 170$, 69.1%) and an annual household income of ≥ 7 million Japanese yen ($n = 168$, 68.3%). Sixteen (6.5%) participants required emotional support as assessed by midwives or nurses. However, the participants did not receive any follow-up care during the period between discharge from the hospital post-delivery and their one-month postpartum check-up. All participants (100%) received support with household chores and/or child-rearing during the first month postpartum, and 173 (70.3%) received meal preparation support during this period. Additionally, 180 (73.5%) were giving attention to their dietary intake.

The overall prevalence of depressive symptoms in this study was 19.5% ($n = 48$). The overall mean (SD) EPDS score was 5.5 (4.4), and the mean (SD) EPDS score of participants with depressive symptoms was 12.6 (3.4) (Table 1).

In the bivariate analysis, the participants with depressive symptoms had significantly higher dietary intakes of EPA + DHA and vitamin D (Table 1). No significant differences were observed in total energy intake or the intake of other nutrients. Additionally, higher educational level and need for emotional support as assessed by midwives or nurses were significantly associated with depressive symptoms. No significant differences were observed in other variables between both groups (Table 1).

Factors related to depressive symptoms

As shown in Table 2, dietary nutrient intake was not significantly associated with depressive symptoms at one month postpartum in the three models of each nutrient (EPA + DHA: adjusted odds ratio [AOR] = 4.05; 95% confidence interval [CI], 0.91 – 18.03;

vitamin D: AOR = 1.07; 95% CI, 0.99–1.16; and vitamin B12: AOR = 1.08; 95% CI, 0.94 – 1.23). However, higher educational level (Model 1: AOR = 2.35; 95% CI, 1.02–5.39; Model 2: AOR = 2.32; 95% CI, 1.01 – 5.33; and Model 3: AOR = 2.39; 95% CI, 1.04– 5.48) and need for emotional support as assessed by midwives or nurses (Model 1: AOR = 3.32; 95% CI, 1.13 – 9.74; Model 2: AOR = 3.49; 95% CI, 1.20 – 10.17; and Model 3: AOR = 3.39; 95% CI, 1.16 – 9.88) were significantly associated with an increased risk of depressive symptoms at one month postpartum.

Table 1. Participants' characteristics and dietary intake

	All (n=246)	EPDS score \geq 9 [†] (n=48)	EPDS score < 9 [†] (n=198)	P-value [‡]
Demographic and Socioeconomic characteristics				
Age [years]	35.2 \pm 4.5	35.0 \pm 5.1	35.3 \pm 4.3	0.727
Age				
\geq 35 years	138 (56.1)	24 (50.0)	114 (57.6)	0.343
Pre-pregnancy body mass index [kg/m ²]	20.6 \pm 2.7	20.4 \pm 2.0	20.7 \pm 2.8	0.441
Weight change during the first month postpartum [kg] [§] [n=245]	-7.2 \pm 2.2	-7.1 \pm 1.9	-7.2 \pm 2.3	0.789
Educational Level				
University/postgraduate	170 (69.1)	40 (83.3)	130 (65.7)	0.017*
High school/junior or technical college	76 (30.9)	8 (16.7)	68 (34.3)	
Annual household income				
\geq 7 million Japanese yen	168 (68.3)	32 (66.7)	136 (68.7)	0.787
Employment status				
Housewife	84 (34.1)	16 (33.3)	68 (34.3)	0.953
On maternity leave	150 (61.0)	30 (62.5)	120 (60.6)	
Working or attending school	12 (4.9)	2 (4.2)	10 (5.1)	
Marital status: Married	245 (99.6)	47 (97.9)	198 (100.0)	0.195
Obstetric factors				
Parity: Primiparous	145 (58.9)	32 (66.7)	113 (57.1)	0.225
Delivery mode: Normal vaginal delivery	139 (56.5)	27 (56.3)	112 (56.6)	0.968
Infertility treatment: Yes	68 (27.6)	14 (29.2)	54 (27.3)	0.792
Amount of bleeding at delivery				
\geq 500 mL	144 (58.5)	25 (52.1)	119 (60.1)	0.312
Hemoglobin level in the last trimester (35–36weeks) [g/dL]	11.2 \pm 0.9	11.3 \pm 1.0	11.1 \pm 0.9	0.406
Hemoglobin level at the time of hospital discharge [g/dL]	9.8 \pm 1.3	9.9 \pm 1.2	9.8 \pm 1.3	0.638
Gestational weeks at delivery	39.0 \pm 1.3	39.3 \pm 1.3	39.0 \pm 1.3	0.148
Birth weight [g]	3005 \pm 362	2988 \pm 311	3009 \pm 374	0.714
Infant's sex: Male	145 (58.9)	31 (64.6)	114 (57.6)	0.376
Breastfeeding status				
Breast milk main	201 (81.7)	37 (77.1)	164 (82.8)	0.356
Formula main	45 (18.3)	11 (22.9)	34 (17.2)	
Psychosocial factors				
EPDS score	5.5 \pm 4.4	12.6 \pm 3.4	3.7 \pm 2.3	
A history of mental illness: Yes	15 (6.1)	4 (8.3)	11 (5.6)	0.501
Need for emotional support as assessed by midwives or nurses: Yes [¶]	16 (6.5)	7 (14.6)	9 (4.5)	0.020*
Family support				
Household chores and/or child rearing support during the first month postpartum: Yes	246 (100.0)	48 (100.0)	198 (100.0)	
Meal preparation support during the first month postpartum: Yes	173 (70.3)	33 (68.8)	140 (70.7)	0.790
Dietary characteristics				
Give attention to dietary intake: Yes	180 (73.5)	38 (79.2)	142 (72.1)	0.319
Use of supplements: Yes	100 (40.7)	19 (39.6)	81 (40.9)	0.867
Dietary intake**				
Total energy intake (kcal/day)	1818 (1502, 2101)	1905 (1569, 2122)	1807 (1495, 2070)	0.231
n-3 polyunsaturated fatty acid (% of energy) ^{††}	1.26 (1.05, 1.48)	1.32 (1.14, 1.60)	1.26 (1.05, 1.47)	0.142
EPA + DHA (% of energy) ^{††}	0.34 (0.24, 0.47)	0.40 (0.30, 0.55)	0.33 (0.23, 0.46)	0.017*
Vitamin D (μ g/1000 kcal) ^{††}	6.01 (4.32, 8.68)	6.95 (5.31, 9.54)	5.95 (4.18, 8.49)	0.033*
Vitamin B ₂ (mg/1000 kcal) ^{††}	0.70 (0.61, 0.81)	0.73 (0.59, 0.80)	0.69 (0.62, 0.81)	0.903
Vitamin B ₆ (mg/1000 kcal) ^{††}	0.67 (0.58, 0.79)	0.70 (0.58, 0.79)	0.66 (0.59, 0.79)	0.681
Vitamin B ₁₂ (μ g/1000 kcal) ^{††}	4.26 (3.19, 5.79)	4.52 (3.69, 6.54)	4.14 (3.10, 5.62)	0.057
Folate (μ g/1000 kcal) ^{††}	172.80 (139.08, 219.35)	176.54 (132.75, 216.30)	172.05 (140.18, 224.07)	0.924
Iron (mg/1000 kcal) ^{††}	4.22 (3.60, 4.94)	4.41 (3.58, 4.88)	4.18 (3.60, 5.00)	0.826
Zinc (mg/1000 kcal) ^{††}	4.61 (4.21, 5.00)	4.64 (4.20, 4.95)	4.60 (4.19, 5.00)	0.966

Data are presented as mean \pm SD, n (%) or median (25th percentile, 75th percentile).

*P -value < 0.05. [†]Depressive symptoms were defined as having a scale score of \geq 9 on Edinburgh Postnatal Depression Scale (EPDS).

[‡]Demographic variables were compared between 2 groups using Student's *t*-test or the Mann-Whitney U test for continuous variables, and chi-square test or Fisher's exact test for categorical variables.

[§]Weight change during the first month postpartum was determined by calculating at one month of postpartum weight [kg] – at final prenatal check-up's weight [kg].

^{||}Edinburgh Postnatal Depression Scale (Score range: 0–30); Higher scores indicate more symptoms of depression.

[¶]Participants were assessed as need for emotional support from midwives or nurses either during their pregnancy or hospitalization.

**Dietary intake was assessed using the brief-type self-administered diet history questionnaire (BDHQ).

^{††}Values for intake are medians of adjusted energy intake by using density method.

Missing data was not included.

Table 2. Multiple logistic regression analysis of factors related to depressive symptoms* (n = 246)**

Variables	Model 1			Model 2		Model 3	
	Unadjusted Odds ratio (95% CI [†])	Adjusted Odds ratio [‡] (95% CI [†])	P-value	Adjusted Odds ratio [‡] (95% CI [†])	P-value	Adjusted Odds ratio [‡] (95% CI [†])	P-value
Dietary nutrient intake							
EPA + DHA (% of energy) [§]	4.65 (1.11–19.41)	4.05 (0.91–18.03)	0.066	–	–	–	–
Vitamin D (µg/1000 kcal) [§]	1.08 (0.99–1.16)	–	–	1.07 (0.99–1.16)	0.090	–	–
Vitamin B ₁₂ (µg/1000 kcal) [§]	1.09 (0.96–1.24)	–	–	–	–	1.08 (0.94–1.23)	0.284
Obstetric factors							
Parity	1.50 (0.78–2.92)	1.49 (0.75–2.99)	0.257	1.51 (0.76–3.02)	0.244	1.48 (0.74–2.95)	0.267
Delivery mode [¶]	1.01 (0.54–1.91)	0.93 (0.48–1.80)	0.821	0.91 (0.47–1.76)	0.770	0.93 (0.48–1.81)	0.833
Demographic and Socioeconomic characteristic							
Educational level ^{**}	2.62 (1.16–5.90)	2.35 (1.02–5.39)	0.044*	2.32 (1.01–5.33)	0.047*	2.39 (1.04–5.48)	0.039*
Psychosocial factor							
Need for emotional support as assessed by midwives or nurses ^{††}	3.59 (1.26–10.18)	3.32 (1.13–9.74)	0.029*	3.49 (1.20–10.17)	0.022*	3.39 (1.16–9.88)	0.025*

*P < 0.05. †CI=confidence interval. ‡Multiple logistic regression analysis was adjusted for the variables in each model

§Values for intake are medians of adjusted energy intake by using density method. ||Primipara=1, Multipara=0

¶Normal vaginal delivery=1, Cesarean section, forceps delivery or vacuum delivery=0 **University/postgraduate=1, High school/junior or technical college=0

††Participants were assessed as need for emotional support from midwives or nurses either during pregnancy or hospitalization: Yes=1, No=0

***Depressive symptoms (EPDS score ≥ 9)

DISCUSSION

We performed this study to reveal associations between dietary nutrient intake and depressive symptoms among one month postpartum women, because the associations were controversial. As results, dietary nutrient intake was not found to be significantly associated with depressive symptoms. Meanwhile, we found that higher educational level and need for emotional support as assessed by midwives or nurses were significantly associated with an increased risk of depressive symptoms in this study. Associations were evident after adjustments for a wide range of possible confounding demographic, the obstetric factors, and lifestyle and dietary habits of women change considerably before and after childbirth which have not been included in previous studies. To our knowledge, the study is the first one to research the associations after adjustments a wide range of possible confounder.

Participants' characteristics

Our study's participants had a relatively higher socioeconomic status than the general Japanese population. The mean (SD) maternal age was 35.2 (4.5) years, with 56.1% of participants aged ≥ 35 years, which was higher than the range of the maternal age group with the highest birth rate in Japan (30–34 years) (Ministry of Health, Labor and Welfare, 2010a). Women with an education above university or postgraduate level accounted for 69.1% of participants, which was higher than that of the general population of Japanese women aged 20 – 49 years (16.8%) (Statistics Bureau, Ministry of Internal Affairs and Communications, 2010). Moreover, women with a household income of ≥ 7 million Japanese yen accounted for 68.3% of participants. This proportion was higher than that of households with children in the general population (39.4%) (Ministry of Health, Labor and Welfare, 2011). While the prevalence of depressive symptoms was 19.5% in this study, which is higher than the 11% reported in previous study in Japan (Mori et al., 2011). In the multivariate analysis, higher educational level was significantly associated with an increased risk of depressive symptoms in this study population. Thus, the high percentage of advanced educational attainment among study participants might have influenced the results.

Additionally, in multivariate analysis, we assumed that one variable required 10

samples, and 4-5 independent variables used. Therefore, the sample size was sufficient.

Factors related to depressive symptoms

Dietary nutrient intake

Dietary nutrient intake was not significantly associated with depressive symptoms at one month postpartum in this study, although the sample size was sufficient. The study participants may have had a relatively higher socioeconomic status than the general Japanese population, which may have affected the result. A previous study has reported that among a group of pregnant Japanese women, a higher educational level was associated with more favorable dietary intake patterns (Murakami et al., 2009). Additionally, in the general Japanese population, those with higher income and higher education were found to be more likely to engage in habitual exercise and favorable health behaviors (Murakami et al., 2011). Moreover, an association between higher household expenditure and a healthy and balanced nutrient intake has been reported (Fukuda & Hiyoshi, 2012).

Here, 73.5% of the participants were giving attention to their dietary intake, and the group with depressive symptoms had better dietary nutrient intake than those in a previous study (Matsumoto et al., 2018). Therefore, few participants may have had a low dietary nutrient intake that contributed to depressive symptoms. Because the participants had a high socioeconomic status and may have had a favorable dietary intake pattern, a significant relationship between dietary nutrient intake and depressive symptoms could not be found. Hence, further research conducted among women from a more diverse socioeconomic population is needed to identify this relationship.

However, for participants both groups, dietary nutrient intake was insufficient according to the dietary reference intakes for Japanese (Ministry of Health, Labor and Welfare, 2020), except for vitamin B12. During the postpartum period, women need to consume sufficient nutrients for physical recovery and lactation. Thus, healthcare providers should pay attention to the dietary intake of postpartum women in Japan.

Other variables

To our knowledge, the study is the first one to find that higher educational level was found to be significantly related to depressive symptoms among one month postpartum women. Previous study reported that Japanese people with higher levels of education were more likely to have mood disorders (Ishikawa et al., 2016). Although the previous study was not limited to postpartum depression, this study's results that higher educational level is a risk factor of depressive symptoms is an explainable phenomenon.

Additionally, a previous study with Japanese participants has indicated that highly educated women tended to offer better opportunities for their child, making the best use of previous life experiences, and mobilizing economic, cultural, and social resources (Honda, 2008). Therefore, highly educated women may be more likely to engage in child-rearing. However, in the first month following childbirth, the pressures of child-rearing can easily lead to maternal psychological instability (Sakanashi et al., 2015). A previous study with general Japanese subjects has reported that despite the majority of mothers receiving housekeeping and/or child-rearing support during the first month after birth, 60–70% of mothers were tired, and >10% of mothers wanted to give up child-rearing (Shimada et al., 2001). Considering this situation among the general population, highly educated women who are more likely to engage in child-rearing could feel a greater level of childcare stress, which may lead to depressive symptoms.

However, the mechanisms underlying how a high educational level is related to depressive symptoms remain unclear. Further research, including evaluation of psychological aspects, is needed to clarify the relationship between high educational level

and depressive symptoms. Additionally, attention should be focused on highly educated women when implementing PPD support programs.

The need for emotional support as assessed by midwives or nurses (e.g., in participants who manifested strong anxiety during pregnancy or experienced maternity blues after childbirth) was found to be significantly related to depressive symptoms. This finding was supported by previous studies reporting that prenatal anxiety and maternity blues were risk factors for PPD (Liu et al., 2022; Zhao & Zhang, 2020).

Presently in Japan, much importance is placed on support for women who are predicted to have difficulties (such as younger age, economic matters, pregnancy conflict, and other factors) in caring for their child, and are recognized as needing child-rearing support prior to delivery (Ministry of Health, Labor and Welfare, 2010b). Therefore, support for women of high socioeconomic status is often overlooked. However, even for women of high socioeconomic status with no evident signs of being at high risk of PPD, for those assessed by midwives or nurses as needing emotional support either during pregnancy or while hospitalized, it may be important to undertake continued follow-up to detect and provide support for those who may develop PPD.

Limitations of the research

There are several limitations to the present study. First, the results may not be generalizable to all Japanese postpartum women because the study was conducted at a single hospital in an urban area, and the age, educational level, and household income of participants were higher than those of the general Japanese population. However, these results can adapt higher socioeconomic status group. Second, although we used a validated, brief-type, self-administered diet history questionnaire, as mothers were in a special living environment in the first month after childbirth, they may not have been able to determine the correct quantity to ingest for one meal. Third, detailed analysis considering the intake of nutrients from supplements has not been possible, although there was no significant difference between the two groups. Finally, selection bias may have affected the results; women with depressive symptoms may have refused to participate in this study.

CONCLUSION

Dietary nutrient intake was not significantly associated with depressive symptoms at one month postpartum in this study. These results may have been influenced by the fact that the group of participants in this study had a higher socioeconomic status than the general population. Further research is needed to identify the relationship between dietary nutrient intake and depressive symptoms and should be conducted among women from a more diverse socioeconomic population.

Additionally, it may be important for PPD support systems to pay attention to highly educated women and to undertake continued follow-up for women who are assessed by midwives or nurses as needing emotional support either during pregnancy or while in the hospital.

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REFERENCES

- Cox, J.L., Holden, J.M., & Sagovsky, R. (1987). Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *British Journal of Psychiatry*, *150*, 782–786. <https://doi.org/10.1192/bjp.150.6.782>
- Ellsworth-Bowers, E.R., & Corwin, E.J. (2012). Nutrition and the psychoneuroimmunology of postpartum depression. *Nutrition Research Reviews*, *25*, 180–192. <https://doi.org/10.1017/s0954422412000091>
- Fukuda, Y., & Hiyoshi, A. (2012). High quality nutrient intake is associated with higher household expenditures by Japanese adults. *Bioscience Trends*, *6*, 176–182. <https://doi.org/10.5582/bst.2012.v6.4.176>
- Hamazaki, K., Takamori, A., Tsuchida, A., Kigawa, M., Tanaka, T., Ito, M., ... Katoh, T. (2018). Dietary intake of fish and n-3 polyunsaturated fatty acids and risks of perinatal depression: The Japan Environment and Children's Study (JECS). *Journal of Psychiatric Research*, *98*, 9–16. <https://doi.org/10.1016/j.jpsychires.2017.11.013>
- Hamazaki, K., Matsumura, K., Tsuchida, A., Kasamatsu, H., Tanaka, T., Ito, M., ... the Japan Environment and Children's Study Group. (2020). Dietary intake of fish and n-3 polyunsaturated fatty acids and risk of postpartum depression: a nationwide longitudinal study – the Japan Environment and Children's Study (JECS). *Psychological Medicine*, *50*, 2416–2424. <https://doi.org/10.1017/s0033291719002587>
- Honda, Y. (2008). *The Bottleneck of family education: Japanese mothers impelled to good parenting*. Keisoshobo (in Japanese).
- Ishikawa, H., Kawakami, N., & Kessler, R.C. (2016). Lifetime and 12-month prevalence, severity and unmet need for treatment of common mental disorders in Japan: Results from the final dataset of World Mental Health Japan Survey. *Epidemiology and Psychiatric Sciences*, *25*, 217–229. <https://doi.org/10.1017/s2045796015000566>
- Kobayashi, S., Honda, S., Murakami, K., Sasaki, S., Okubo, H., Hirota, N., ... Date, C. (2012). Both comprehensive and brief self-administered diet history questionnaires satisfactorily rank nutrient intakes in Japanese adults. *Journal of Epidemiology*, *22*, 151–159. <https://doi.org/10.2188/jea.je20110075>
- Kobayashi, S., Murakami, K., Sasaki, S., Okubo, H., Hirota, N., Notsu, A., ... Date, C. (2011). Comparison of relative validity of food group intakes estimated by comprehensive and brief-type self-administered diet history questionnaires against 16 d dietary records in Japanese adults. *Public Health Nutrition*, *14*, 1200–1211. <https://doi.org/10.1017/s1368980011000504>
- Letourneau, N.L., Dennis, C.L., Benzies, K., Duffett-Leger, L., Stewart, M., Tryphonopoulos, P., ... Watson, W., (2012). Postpartum depression is a family affair: Addressing the impact on mothers, fathers, and children. *Issues in Mental Health Nursing*, *33*, 445–457. <https://doi.org/10.3109/01612840.2012.673054>
- Liu, X., Wang, S., & Wang, G. (2022). Prevalence and Risk Factors of Postpartum Depression in Women: A Systematic Review and Meta-analysis. *Journal of clinical nursing*, *31*(19-20), 2665–2677. <https://doi.org/10.1111/jocn.16121>
- Matsumoto, H., Matsuzaki, M., Shiraishi, M., Haruna, M. Relationship between body image and dietary intake among women at one month postpartum. (2018). *Bosei eisei*, *59*(2), 406–415 (in Japanese).
- Matsumura, K., Hamazaki, K., Tsuchida, A., Kasamatsu, H., Inadera, H., Japan Environment and Children's study (JECS) Group. (2019). Education level and risk of

- postpartum depression: results from the Japan Environment and Children's Study (JECS). *BMC Psychiatry*, 19, 419. <https://doi.org/10.1186/s12888-019-2401-3>
- Ministry of Health, Labor and Welfare. (2011). *Comprehensive survey of living conditions*. <http://www.mhlw.go.jp/toukei/saikin/hw/k-tyosa/k-tyosa10/2-4.html>
- Ministry of Health, Labor and Welfare. (2020). *Dietary reference intakes for Japanese*. Dai-ichi shuppan.
- Ministry of Health, Labor and Welfare. (2010a). *Specified report of vital statistics in FY 2010, Live Births*. http://www.mhlw.go.jp/english/database/db-hw/FY2010/live_births.html
- Ministry of Health, Labor and Welfare. (2010b). *Guideline for nurturing support and home visiting services*. <http://www.mhlw.go.jp/bunya/kodomo/kosodate08/03.html>
- Miyake, Y., Sasaki, S., Tanaka, K., Yokoyama, T., Ohya, Y.,...The Osaka Maternal and Child Health Study Group. (2006). Dietary folate and vitamins B12, B6, and B2 intake and the risk of postpartum depression in Japan: The Osaka Maternal and Child Health Study. *Journal of Affective Disorders*, 96, 133–138. <https://doi.org/10.1016/j.jad.2006.05.024>
- Miyake, Y., Sasaki, S., Yokoyama, T., Tanaka, K., Ohya, Y., Fukushima, W.,...The Osaka Maternal and Child Health Study group. (2006). Risk of postpartum depression in relation to dietary fish and fat intake in Japan: The Osaka Maternal and Child Health Study. *Psychological Medicine*, 36, 1727–1735. <https://doi.org/10.1017/s0033291706008701>
- Miyake, Y., Tanaka, K., Sasaki, S., & Hirota, Y. (2011). Employment, income, and education and risk of postpartum depression: The Osaka Maternal and Child Health Study. *Journal of Affective Disorders*, 130, 133–137. <https://doi.org/10.1016/j.jad.2010.10.024>
- Mori, T., Tsuchiya, K.J., Matsumoto, K., Matsumoto, K., Suzuki, K., Mori, N., & Takei, N. (2011). Psychosocial risk factors for postpartum depression and their relation to timing of onset: The Hamamatsu Birth Cohort (HBC) Study. *Journal of Affective Disorders*, 135, 341–346. <https://doi.org/10.1016/j.jad.2011.07.012>
- Murakami, K., Hashimoto, H., Lee, J.S., Kawakubo, K., Mori, K., & Akabayashi, A. (2011). Distinct impact of education and income on habitual exercise: A cross-sectional analysis in a rural city in Japan. *Social Science & Medicine*, 73, 1683–1688. <https://doi.org/10.1016/j.socscimed.2011.09.024>
- Murakami, K., Miyake, Y., Sasaki, S., Tanaka, K., Yokoyama, T., Ohya, Y., Fukushima, W.,...The Osaka Maternal and Child Health Study Group. (2008). Dietary glycemic index and load and the risk of postpartum depression in Japan: The Osaka Maternal and Child Health Study. *Journal of Affective Disorders*, 110, 174–179. <https://doi.org/10.1016/j.jad.2007.12.230>
- Murakami, K., Miyake, Y., Sasaki, S., Tanaka, K., & Arakawa, M. (2010). Fish and n-3 polyunsaturated fatty acid intake and depressive symptoms: Ryukyus Child Health Study. *Pediatrics*, 126, e623–e630. <https://doi.org/10.1542/peds.2009-3277>
- Murakami, K., Miyake, Y., Sasaki, S., Tanaka, K., Ohya, Y., & Hirota, Y. (2009). Education, but not occupation or household income, is positively related to favorable dietary intake patterns in pregnant Japanese women: The Osaka Maternal and Child Health Study. *Nutritional Research*, 29, 164–172. <https://doi.org/10.1016/j.nutres.2009.02.002>
- Nishimura, M., Takemori, K., & Yamamoto, H. (2008). Life events and lifestyle of women in their twenties and thirties: Influence of marriage, pregnancy, giving birth, and child-care. *Japanese Journal of Public Health*, 55, 503–510 (in Japanese).

- Okano, T., Murata, M., Masuji, F., Tamaka, R., Nomura, J., & Miyaoka, H. (1996). Validation and reliability of Japanese version of the EPDS (Edinburgh Postnatal Depression Scale). *Archives of Psychiatric Diagnostics and Clinical Evaluation*, 7, 525–533 (in Japanese).
- Okubo, H., Miyake, Y., Sasaki, S., Tanaka, K., Murakami, K., & Hirota, Y. (2011). Dietary patterns during pregnancy and the risk of postpartum depression in Japan: The Osaka Maternal and Child Health Study. *British Journal of Nutrition*, 105, 1251–1257. <https://doi.org/10.1017/s0007114510004782>
- Rechenberg, K., & Humphries, D. (2013). Nutritional interventions in depression and perinatal depression. *Yale Journal of Biology and Medicine*, 86, 127–137.
- Sakanashi, K., Katsukawa, Y., Mizuno, S., & Kato, C. (2015). Mental health and child-rearing activities of mothers with 1-month-old infants. *Kanto Gakuin University Journal of Nursing*, 2, 1–9 (in Japanese).
- Shimada, M., Watanabe, H., Kamiya, S., Nakane, N., Toda, R., Agata, T., ... Suzuki, S. (2001). A nationwide survey on mothers in a one-month postpartum period regarding newborn care & personal health concerns and their needs for support. *The Journal of Child Health*, 60, 671–679 (in Japanese).
- Statistics Bureau, Ministry of Internal Affairs and Communications, Japan. (2010). *Population census*. <http://www.stat.go.jp/data/kokusei/2010/users-g/qa-1.htm>
- The Japan Society of Obstetrics and Gynecology. (2016). *The report of joint conference on maternal mental health 2015*. <http://fa.kyorin.co.jp/jsog/readPDF.php?file=68/1/068010129.pdf>
- Tsunoda, K., Hamazaki, K., Matsumura, K., Kasamatsu, H., Tsuchida, A., Inadera, H., & Japan Environment and Children's Study (JECS) Group (2023). Dietary Intake of Vitamin D during Pregnancy and the Risk of Postpartum Depressive Symptoms: The Japan Environment and Children's Study. *Journal of nutritional science and vitaminology*, 69(1), 14–20. <https://doi.org/10.3177/jnsv.69.14>
- Willett, W.C., Howe, G.R., & Kushi, L.H. (1997). Adjustment for total energy intake in epidemiologic studies. *American Journal of Clinical Nutrition*, 65, 1220S–1231S. <https://doi.org/10.1093/ajcn/65.4.1220s>
- Yonkers, K.A., Vigod, S., & Ross, L.E. (2011). Diagnosis, pathophysiology, and management of mood disorders in pregnant and postpartum women. *Obstetrics & Gynecology*, 117, 961–977. <https://doi.org/10.1097/aog.0b013e31821187a7>
- Zhao, X. H., & Zhang, Z. H. (2020). Risk factors for postpartum depression: An evidence-based systematic review of systematic reviews and meta-analyses. *Asian journal of psychiatry*, 53, 102353. <https://doi.org/10.1016/j.ajp.2020.102353>